MATH 442: Mathematical Modeling

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Project Zombie

Instructions You are to work alone or in groups of 2 to complete the following project. Groups will either be assigned by the instructor or created with the consent of the instructor. You are to use pair programming techniques to do the MATLAB. You are to split the writing tasks and critique each others work, bringing everything together into one coherent report at the end. Keep track of who does what and how each person contributes to this assignment; this will also be handed in!

Your job is to explain this topic and your modeling in your own words. You will probably use references to review the topics. You should cite these references in your bibliography. If you quote from a reference, you must use quotes and a citation. If you paraphrase closely or take a problem from a reference, you use a citation. Avoid excessive quotation and paraphrasing. To accomplish this, as much as possible do not look directly at a reference while writing up your explanation, so that you use your own words. If you need to, make an outline of the major ideas and then refer back to your outline while you are writing.

Things to check before handing in your project:

1. Have you done everything you were asked to do?
2. Is the math right? If not, get it fixed.
3. Is what you are trying to explain clear?
4. Do your graphs clearly show the conclusions you reach?
5. Are the spelling, grammar, and English usage correct and concise?
6. Do you think this is A, B or C level work?
7. Run the document through a spell checker!
8. Have the Writing Center or some other good writer read your document and critique it; then edit your document taking those comments into account.

By the end of this project, you and your partners should have a thorough understanding of curve fitting, population models, and how to evaluate the models.

Zombie Apocalypse In [P. Munz and Smith?(2009)], they analyze an outbreak of zombiism as an infectious disease and discover that the only stable equilibrium is one in which all humans are turned into zombies. This is called the Zombie Apocalypse.

Your mission is to read their paper and question their assumptions. Can you find an incorrect assumption? How do you change the model for this? Can you find a stable equilibrium?

You may also think of other ways that humans might remove dangerous zombies from the population. Does this change the model? In what ways? And does this allow for a stable equilibrium?

You should do a web search and a library search to see if you can find other publications modeling outbreaks of zombie infections, and what conclusions those come to.

You should learn some basics about disease modeling, at the very least reading about it on Wikipedia [Wikipedia(2011)].

Your modeling goals are:

I. Reproduce some of the results from the paper. You can use `ode45` or another MATLAB ODE solver to solve the differential equations rather than programming the Euler method.

II. Once you have this working, evaluate and change the modeling assumptions.

III. Write equations to reflect your changes, and see how this influences the equilibria.

IV. See if you can figure out what are the best ways for humans to fight the zombies and prevent the apocalypse.

Your write-up should be paper/report roughly 1500-3000 words long, not including the bibliography. It should include:

(a) A 100-200 word abstract summarizing your paper.

(b) An introduction. In the introduction you should:

   i. Explain your understanding of zombies and zombiism (with references to your sources, as in the original paper).

   ii. Discuss the prior paper, and its results.

(c) A modeling section in which you explain your new modeling assumptions (similar to section 2, 3, 4 of the original paper), and your results

(d) You may have two or three subsections in which you explore alternatives (similar to the original paper). In particular, you should take into account what actions the humans might take.

(e) In the modeling section or subsections, you should include graphs to show how the human and zombie populations change over time, a calculation of the equilibria, and a stability analysis.

(f) A results and conclusion section in which you include

   i. An overall summary of your results.

   ii. An evaluation of which model(s) created the best scenarios for the humans. Are there any ways to avoid the apocalypse?

   iii. Any criticisms of your models that you can see using your "uncommon sense".

   iv. A concluding paragraph that sums up the paper.

(g) A bibliography where you cite your sources of information.

You are invited and encouraged to have as much fun with this topic as you can!

Grading You will hand in your report along with the group work assessment. Submit the LaTeXfiles, graphs and MATLAB files on eLearning. You will use TurnItIn on eLearning to submit the PDF of your final report. If you can include the group work assessment as an appendix to your report, I would be grateful. Your group only needs to hand in 1 PDF and 1 set of files for this project.

1. 5 points for the abstract.
2. 20 points for correct and complete scientific/mathematical explanation of the general problem and equations, and data.
3. 25 points for each section on a model (assuming 2)
4. 25 points for conclusions.
5. Each person will be graded based on the distribution of work in the group as well as the quality of the finished product.

Total: 100 points; weight is 2x that of previous projects

References

[P. Munz and Smith?(2009)] J. Imad P. Munz, I. Hudea and R. J. Smith? When zombies attack! mathematical modeling of an outbreak of zombie infection. In J. M. Tchuenche and C. Chiyaka, editors, *Infectious Disease Modelling Research Progress*, pages 133–150. July 2009. ISBN 978-1-60741-347-9. URL `http://mysite.science.uottawa.ca/rsmith43/Zombies.pdf`.

[Wikipedia(2011)] Wikipedia. Compartmental models in epidemiology, 2011. URL http://en.wikipedia.org/wiki/Compartmental_models_in_epidemiology.